TM 10049A-12

Test Set 4131
BIRD

OPERATING INSTRUCTIONS

TEST SET, TACTICAL RADIO MODEL 4131

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1 AUGUST 1986

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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

OPERATE EQUIPMENT SAFELY

During operation, do not exceed the power rating of the test set. Dangerous potentials may exist when RF energy is excessive.

KEEP AWAY FROM LIVE POWER

Do not replace components or attempt to disconnect the load from the transmission line while RF power is being applied. RF energy is a potential health hazard.

The following warnings and cautions appear in the text in this volume, and are repeated here for emphasis.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT

or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131. (Pages 2-2, 4-3, 4-5, 4-7, 4-9, 4-12, 4-14, and 4-23.)

Provide adequate ventilation and observe normal precautions when using dry cleaning solvents. Many dry cleaning agents emit toxic fumes that may be harmful if inhaled. (Page 5-2.)

Personnel can be seriously injured if the lithium battery contained in the Model 4131 is not handled and disposed of properly. Always observe the following guidelines:

- Dispose of the battery properly: never burn, crush, or incinerate.
- Never attempt to recharge the battery.
- Never bypass the fuse.
- If the battery vents gas or becomes hot, stop operating the equipment. Do not handle the battery until it cools and stops venting. (Page 5-15.)

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY

Equipment failure of the Model 4131 and/or the radio set being tested can occur. (Pages 4-3, 4-8, 4-10, 4-12, and 4-15.)

Do not apply RF power to Model 4131 when performing sensitivity test. (Pages 4-17 and 4-18.)

Damage may result when using modulation indicator with power levels greater than 10.0 watts. (Pages 4-23 and 5-13.)

Do not direct a strong stream of water or compressed air at the case, front panel, or components of the test set. (Page 5-1.)

The Model 4131 upper case becomes very hot during the power termination test. (Page 5-12.)

Lithium batteries not used for periods of a few weeks or more or subjected to low temperature for several hours or more, whether contained in the Model 4131 or not, may appear to be dead or discharged. This is a characteristic of lithium batteries. Simply place the function switch in the SELF TEST position and press the PUSH TO TEST pushbutton for 30 seconds. If the battery contains a usable charge, it will operate normally after this time. Failure to observe this caution can result in unnecessary battery replacement. (Page 5-15.)

Install only an approved desiccant. Failure to do so can result in decreased accuracy of the Model 4131 or damage under some environmental conditions. (Page 5-16.)

Use only the special sealing screws supplied to fasten individual components. Use of other screws can result in equipment damage due to the loss of watertight integrity. (Pages 5-18, 5-19, 5-22, and 5-24.)

CHAPTER 1
INTRODUCTION

1-1. PURPOSE AND FUNCTION. The Model 4131 Tactical Radio Test Set checks the operational performance of FM VHF radio sets, such as the AN-VRC 12, 43 through 49 series, AN/PRC-77, AN/PRC-68, and most other FM radio sets operating in the frequency band from 30 to 90 megahertz (MHz).

1-2. CAPABILITIES. In addition to testing the operating performance of a single radio set, the Model 4131 can be used to grade the relative performance of a group of like radio sets. The radio sets with higher or more consistent operating performance can be identified and used in the more critical applications. This is referred to as tactical deployment. A typical example of tactical deployment is the use of radio sets with the best or more consistent selectivity, sensitivity, and power output in the more remote field locations.

a. *Coaxial Load Resistor.* A coaxial load resistor is built into the Model 4131 case lid. It is a 50 ohm line termination which uses the lid for heat dissipation. It provides accurate and practically nonreflective termination for testing and adjusting a transmitter under nonradiating conditions. It is used in place of the antenna.

b. *FM Deviation Indicator.* The FM deviation indicator detects the presence of frequency modulation in a RF carrier. It is equipped with both an earphone and lamp for monitoring. The indicator contains a thruline coupler which enables on the air monitoring of a transmitter.

1-3. PERFORMANCE CHARACTERISTICS. The Model 4131 is a portable, self-contained test set used to test FM tactical radios. Table 1-1 lists the leading particulars and operating parameters of the test set and accessories. Instrument sensitivity, field strength, and testing capabilities are explained in the following paragraphs.

Table 1-1. Table of Specifications

SPECIFICATIONS FOR MODEL 4131 TEST SET

Frequency measurement	
Frequency range	30.000 to 90.000 MHz
Power range	0.5 to 100 watts
Accuracy	±2 kHz
Power measurement (incident and reflected)	
Power range	0.5 to 100 watts
Frequency range	30.000 to 90.000 MHz
Directivity	26 dB minimum
Forward accuracy	±10% *
Reflected accuracy	±[10% of reading + (FWD PWR/400)] *
VSWR (calculated from incident and reflected)	
Result range	1.00 to 100
Accuracy	Dependent upon power measurement accuracy
Sensitivity function	
FM output signals (13 signals)	
Frequency of signal	From 30.000 to 90.000 MHz spaced 5 MHz apart
FM modulation 1 kHz +200 Hz	Resultant carrier deviation for each of the 13 signals; 2 kHz minimum

* Small amounts of AM, up to 10%, are tolerable. However, every 1% of AM can decrease the accuracy by 1%. Use of the Model 4131 with RF signals amplitude modulated above 10% is not recommended because of the resulting inaccuracies.

Table 1-1. Table of Specifications – Continued

FM modulation 150 Hz ±2 Hz	Resultant carrier deviation at 75 MHz; 3.25 kHz (±0.7 kHz)
Signal level	0.50 microvolt (±0.20 microvolt)
Relative field strength function	Displays a relative reading of field strength from 0 to 100. (Approximate adjustment range is 30 dB.)
SELF TEST function	Verifies operation of the majority of the circuitry contained in the Model 4131.
Antenna line section (applies to frequency power, VSWR, and sensitivity functions)	
Impedance	50 ohms
Insertion VSWR	1.05 (–32.2 dB return loss) maximum
Insertion loss	Less than 1% (0.0436 dB)
Connectors	Equipped with two standard female BNC connectors with protective guards
Coaxial load resistor	
Impedance	50 ohms nominal
Power rating	100 watts continuous, 200 watts for 5 seconds
Frequency range	30.000 to 90.000 MHz
VSWR	1.10 to 1 maximum
Connector	Male BNC on 18" of RG-58C/U coaxial cable
FM Deviation Indicator	
Operating frequency	50.00 MHz ±50 kHz
Operating power	0.5 to 10 watts
Peak deviation for "ON" indication	3 kHz ±1 kHz at 5 watts

Table 1-1. Table of Specifications – Continued

Audio frequency response	500 to 3000 Hz
Audio output	3.0 mW maximum into 15 ohms
Input/output impedance	50 ohms nominal
Insertion loss	Less than 1% (–0.0436 dB)
Dimensions (approximate)	
H W D	9 x 8 x 7 in. (22.9 x 20.3 x 17.8 cm)
Weight (approximate)	11 lbs. (5.0 kg) including operator's manual and 1 meter RF power cable
Temperature range (operational)	–4° to +122°F (–20° to +50°C)
Temperature range (deviation indicator)	32° to +122°F (0° to 50°C)

a. *Sensitivity.* The Model 4131 provides 13 output signals to check the relative sensitivity and squelch operation of an FM receiver. The signals are 0.50 (±.20) microvolt in amplitude, 1 at each even 5 MHz frequency in the range from 30 to 90 MHz: one at 35 MHz, one at 40 MHz, etc. Each output signal is simultaneously frequency-modulated with both 1 kHz and 150 Hz tones.

b. *Relative Field Strength.* A relative field strength measurement provides a means for peaking the transmitter-to-antenna coupling of hand-held radio sets. The Model 4131 receives the signal from a small antenna mounted on its front panel. The display of the Model 4131 indicates the relative power received. By peaking the transmitter-to-antenna coupling, this relative power measurement will increase.

c. *RF Measurements.* The following types of RF measurements are performed when the Model 4131 is connected inline between the transmitter and antenna.

(1) *Forward RF Power.* Measured from 0.5 to 100 watts.

(2) *Reflected RF Power.* Measured from 0.5 to 100 watts.

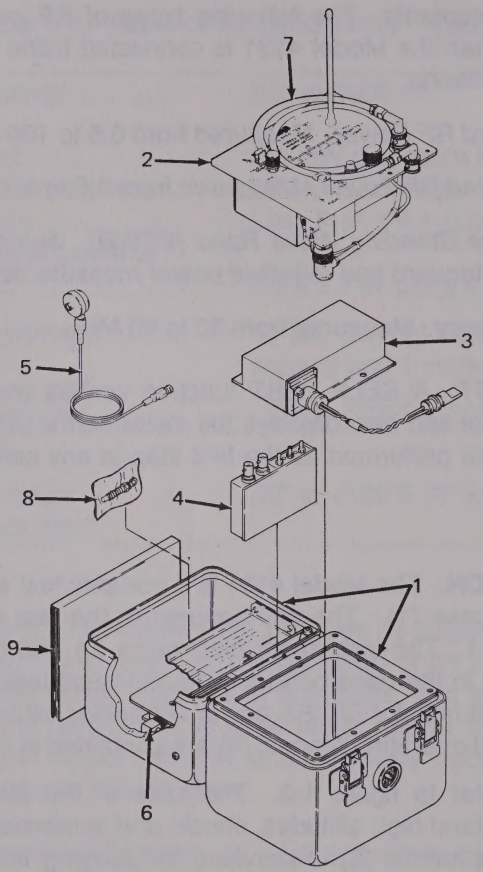
(3) *Voltage Standing Wave Ratio (VSWR).* Automatically calculated using the forward and reflected power measurement data.

(4) *Frequency.* Measured from 30 to 90 MHz.

d. *SELF TEST.* A SELF TEST function verifies that the Model 4131 is operational and also displays the instrument's battery voltage. This test should be performed as the first step in any series of measurements.

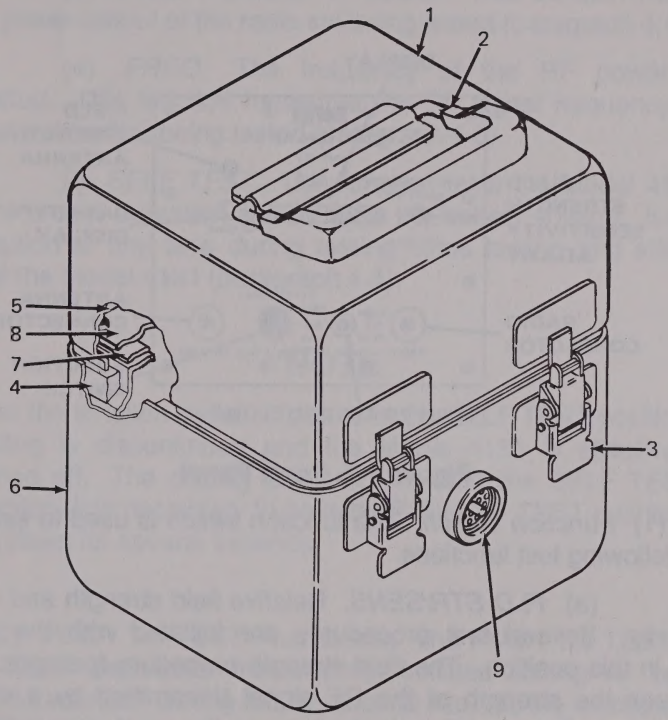
1-4. DESCRIPTION. The Model 4131 is a portable test set contained in an aluminum case (1). The components of the test set are illustrated in figure 1-1. The instrument electronics (2) and battery cover (3) are contained in the case bottom. The deviation indicator (4) and earphone (5), load resistor (6), RF power connector cable (7), calibration probe (8), and operating manual (9) are contained in the case lid.

a. *Case.* Refer to figure 1-2. The case of the Model 4131 is designed to withstand high altitudes, shock, and immersion. On top of the case lid (1) a handle (2) is provided for carrying the set. When closed, clasps (3) hold the lid tightly against gasket (4), hermetically sealing the case. When open, the components stored in the lid are accessible. The lid can be removed by separating hinges (5) at the hinge pins. The bottom (6) is hermetically sealed by flat gasket (7) between front panel (8) and case bottom. A relief valve (9), located on the front of the case, provides automatic two-way pressure venting.



1. Case
2. Electronics
3. Battery cover
4. FM deviation indicator
5. Earphone
6. Coaxial load resistor
7. RF power connector cable
8. Calibration probe
9. Operating manual

Figure 1-1. Model 4131



1. Case lid
2. Handle
3. Clasp
4. Gasket
5. Hinge
6. Bottom
7. Flat gasket
8. Front panel
9. Relief valve

Figure 1-2. Model 4131 Case

b. *Front Panel.* The connectors, various controls, and displays of the Model 4131 are located on the front panel. See figure 1-3. The front panel is hermetically sealed so that the unit can be operated under adverse weather conditions. Each of the items on the front panel are described in the following paragraphs.

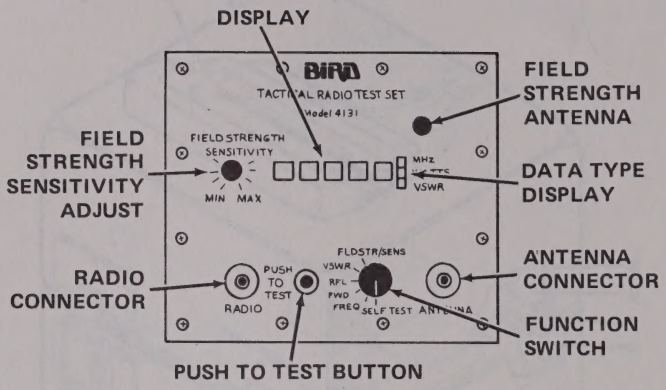


Figure 1-3. Front Panel

(1) *Function Switch.* The function switch is used to select one of the following test functions.

(a) *FLD STR/SENS.* Relative field strength and receiver sensitivity. Several test procedures are initiated with the function switch in this position. The field strength procedure (paragraph 4-10) measures the strength of the RF signal transmitted by a radio set being tested. The sensitivity tests measure the receiver sensitivity of a radio set in three ways: sensitivity (paragraph 4-9.c.), selectivity (paragraph 4-9.d.), and frequency calibration (paragraph 4-9.d.).

(b) *VSWR.* Voltage standing wave ratio. This function calculates the compatibility of the radio set antenna and transmission line (paragraph 4-8).

(c) *RFL.* Reflected RF power. This function measures the RF power that is not radiated due to antenna-to-line mismatch (paragraph 4-7).

(d) *FWD.* Forward RF power. This function measures the RF power output of the radio set being tested (paragraph 4-6).

(e) *FREQ.* The frequency of the RF power being transmitted. This function measures the RF signal frequency of the radio set transmitter being tested (paragraph 4-5).

(f) *SELF TEST.* This function tests the Model 4131 circuitry for proper operation and displays the battery voltage. Selecting this position at any time during testing stops testing and effectively turns off the Model 4131 (paragraph 4-4).

NOTE

After the function switch is placed in the SELF TEST position, testing is discontinued and the Model 4131 is effectively turned off. The display is blank. To start the SELF TEST function, it is necessary to hold the PUSH TO TEST pushbutton down for several seconds.

(2) *PUSH TO TEST Pushbutton.* The PUSH TO TEST pushbutton, when depressed momentarily, initiates testing for approximately 45 seconds. During this 45-second interval, the function switch can be set at any position except SELF TEST. As each position is selected, the test results appear in the display.

(3) *Display.* The Model 4131 display is located across the center of the front panel. The display consists of five windows arranged horizontally and three indicators arranged vertically. The display is made up of high visibility yellow light emitting diodes (LEDs) for easy reading even in high light conditions.

(a) Each of the windows displays a single character made up of seven LED segments, and a single decimal point LED. This arrangement provides maximum readability of numeric characters and

permits formation of some alphabetic characters. The horizontal windows display the numeric value of test measurements and alphanumeric codes.

(b) The three indicators to the right of the windows are labeled: MHz, WATTS, and VSWR. The lighted indicators represent the currently active measurement units and/or test function. Depending on the type of data displayed, one, more, or none of the indicators may be lighted.

1. *MHz.* Frequency measurements are displayed in megahertz. This indicator is lighted when frequency is measured by the test set.

2. *WATTS.* Power measurements are displayed in watts. This indicator lights when the forward RF power or reflected RF power is measured by the test set.

3. *VSWR.* This indicator lights when the displayed value is a comparative value or ratio.

(c) When the PUSH TO TEST pushbutton is depressed, regardless of the function switch setting, the entire display remains off for 2 seconds. Then the MHz, WATTS, and VSWR indicators blink for 3 seconds. During the SELF TEST function, the entire display (.8.8.8.8.8 and the MHz, WATTS, and VSWR indicators) lights for 3 seconds. At the end of the SELF TEST sequence, battery voltage is displayed between dashes, for example: -8.14-.

(4) *RADIO and ANTENNA Connectors.* The RADIO connector is located in the lower left corner of the front panel, and the ANTENNA connector in the lower right. They are both BNC cable connectors. They are used to connect the Model 4131, inline, between the radio being tested and its associated antenna or the coaxial load resistor. The connectors are used for the following measurements.

(a) RF forward power.

(b) RF reflected power.

(c) VSWR.

(d) Frequency of the RF signal transmitted.

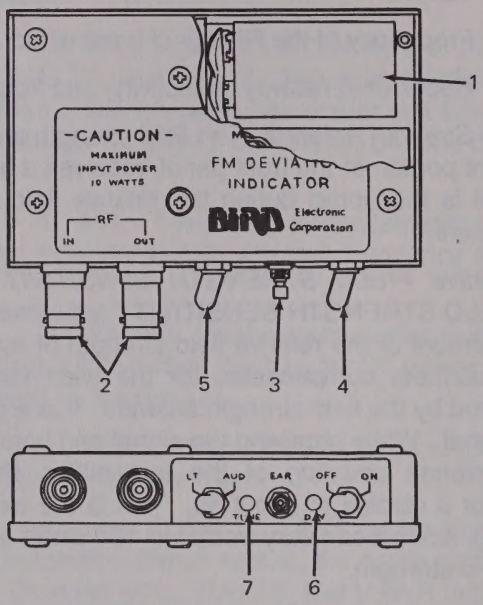
(e) Receiver sensitivity, selectivity, and frequency.

(5) *Field Strength Antenna.* The field strength antenna, located in the upper right portion of the front panel, receives a transmitted signal. This signal is monitored during the relative field strength (FLD STR) measurement.

(6) *Relative FIELD STRENGTH SENSITIVITY Adjustment.* The relative FIELD STRENGTH SENSITIVITY adjustment is used during the measurement of the relative field strength of an RF transmission. This adjustment compensates for the wide variation in field strengths received by the field strength antenna. It is a gain control for the received signal. While receiving the signal and before peaking the transmitter-to-antenna coupling of the transmitter, this adjustment should be set for a display of about 50. This is the mid-range of the possible reading, since it can vary from 0 to 100 when the Model 4131 is measuring field strength.

c. *FM Deviation Indicator.* The deviation indicator (4, figure 1-1) is a self contained unit stored in the case lid. It is stored with its panel and connectors exposed so it can be used without removing it from the case lid. The indicator is held in place by two friction clips and can be removed easily for maintenance or use away from the test set. The earphone and its cable are stored next to the indicator. The deviation indicator is illustrated in figure 1-4.

(1) *Battery.* The deviation indicator is powered by an internal 9 volt battery (1) with an approximate useful life of 120 hours. The battery is held in place by the indicator cover and is connected to the circuitry by snaps. Only a phillips head screwdriver is required for battery replacement.



1. Battery
2. Female BNC connectors
3. Earphone connector
4. ON/OFF switch
5. LT/AUD switch
6. DEV lamp
7. TUNE lamp

Figure 1-4. FM Deviation Indicator

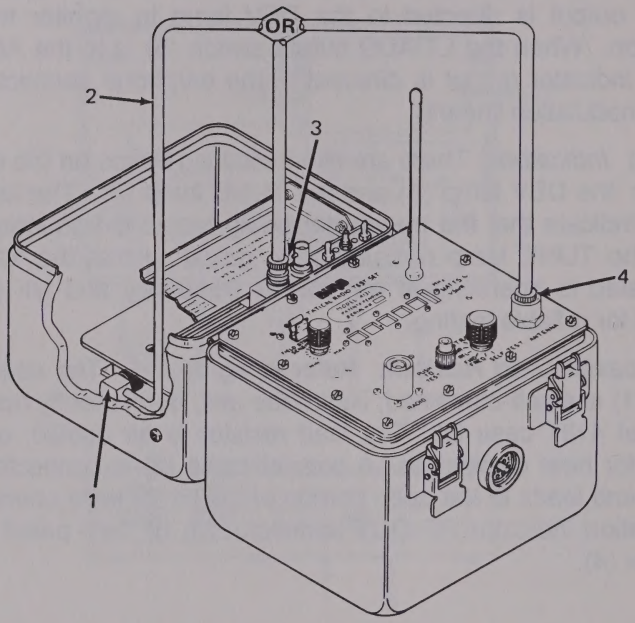
(2) *Connectors.* There are three connectors on the deviation indicator: two female BNC connectors (2) for the RF in and out and earphone connector (3).

(3) *Switches.* There are two switches on the deviation indicator: the OFF/ON switch (4) controls power from the battery, and the LT/AUD switch (5) directs the type of output monitored. The OFF/ON

switch (4) should be in the OFF position unless testing is being performed. When the LT/AUD output switch (5) is in the LT position, the indicator output is directed to the DEV lamp to monitor frequency modulation. When the LT/AUD output switch (5) is in the AUD position, the indicator output is directed to the earphone connector (3) to monitor modulation linearity.

(4) *Indicators.* There are two indicating lamps on the deviation indicator: the DEV lamp (6) and the TUNE lamp (7). The DEV lamp lights to indicate that the transmitter being tested is frequency modulated. The TUNE lamp remains dark indicating that the transmitter being tested is operating at the correct frequency and RF power is sufficient for reliable testing.

d. *Coaxial Load Resistor.* Refer to figure 1-5. The coaxial load resistor (1) is a self-contained, liquid free unit, permanently mounted in the Model 4131 case lid. The load resistor is air cooled, using the case lid for heat dissipation. A coaxial cable (2) is connected to the resistor, and leads to the open portion of the lid for easy connection to the deviation indicator RF OUT connector (3) or front panel antenna connector (4).



1. Coaxial load resistor
2. Coaxial cable
3. Deviation indicator RF OUT connector
4. Antenna connector

Figure 1-5. Coaxial Load Resistor

CHAPTER 2
INSTALLATION

2-1. GENERAL. The Model 4131 Tactical Radio Test Set contains all the instrumentation and accessories required to test and grade FM VHF radio sets for maintenance and tactical deployment. These components are transported in the test set case. The test set is installed at the test site by unpacking and connecting the components required for the planned tests.

2-2. UNPACKING. Open the test set case. Refer to paragraph 1-4, and ensure that all components are present. Visually inspect the components for damage that may have occurred during shipping or transport.

a. Check the position of the function selector switch. The switch should be in the SELF TEST position during transport. If it is not, the battery may be discharged; perform the battery check procedure (paragraph 5-5) before performing any tests.

b. Before making any connections to the unit, refer to paragraph 4-4, and perform the SELF TEST procedure to verify that the unit is working properly.

c. Before making any connections to the deviation indicator, check the battery level. Place the OFF/ON switch in the ON position and observe the TUNE lamp. If the lamp fails to light, the battery is low and must be replaced (paragraph 5-6).

2-3. CONNECTIONS. The Model 4131 tests the performance of a radio set by measuring and analyzing the RF signals generated and detected by the radio set. To measure these signals, the Model 4131 components are either connected inline, between the radio set and

antenna; or set up to monitor radiated signals. Whether radiated or inline signals are monitored depends upon the signal characteristics being analyzed.

a. *Troubleshooting Connections.* Connections for troubleshooting the test set itself are detailed in the troubleshooting procedures. Refer to paragraph 5-4.

b. *Testing Sequence.* After the Model 4131 SELF TEST is performed, the radio set tests can be performed in any sequence. To obtain the most useful results and efficient test plan, arrange the test sequence by setup requirements. Perform all planned tests for one setup before changing to the next setup. It is recommended that inline tests be performed before the radiated field tests.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT

or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

c. *SELF TEST Connections.* The SELF TEST should be performed with no cables attached to the Model 4131. When unpacking the unit, the SELF TEST should be performed before connecting any cables to the Model 4131.

d. *Inline Connections.* Connect the radio and test set components according to the connection diagram in figure 2-1, and the following instructions.

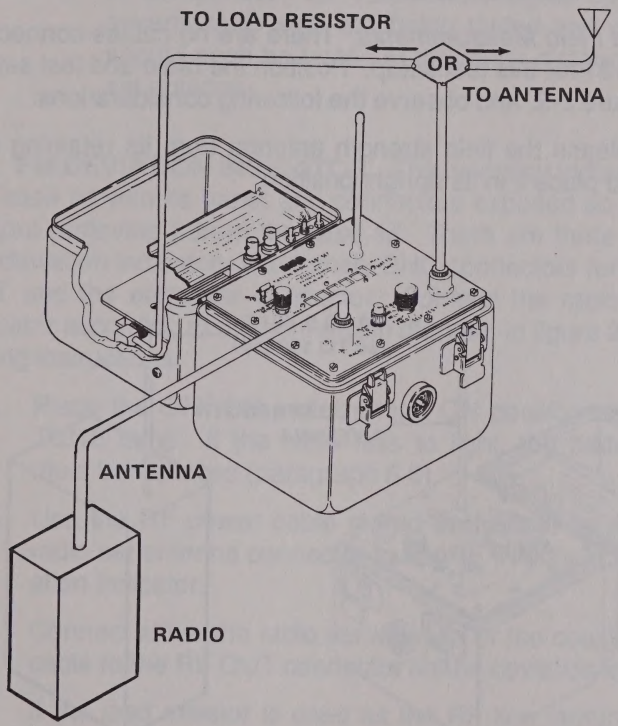


Figure 2-1. Inline Connection Diagram

(1) Use the RF power cable stored in the test set to connect the radio set antenna connector to the RADIO connector on the Model 4131 front panel.

(2) Connect either the radio set antenna or the coaxial load resistor cable to the ANTENNA connector on the Model 4131 front panel.

(3) If the load resistor is used as the RF line termination, position the case lid to ensure air convection around the lid will aid in heat dissipation.

e. *Radiated Field Measurements.* There are no cables connected to the Model 4131 for this test setup. Position the radio and test set as illustrated in figure 2-2, and observe the following considerations.

(1) Release the field strength antenna from its retaining clip and place it in its upright position.

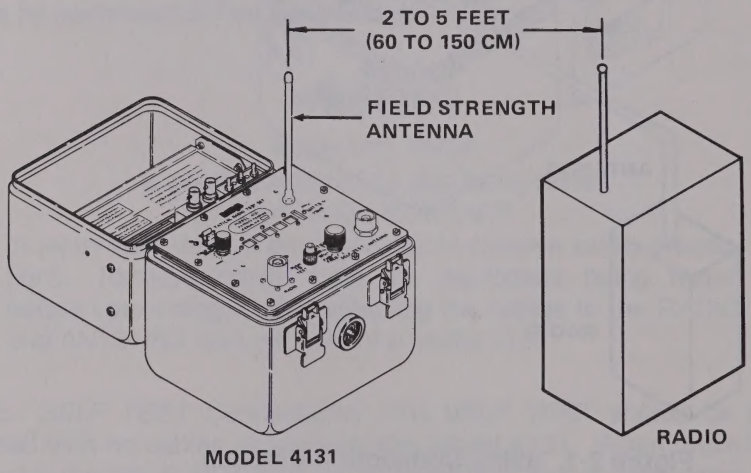


Figure 2-2. Radiated Field Management Setup

(2) As shown in figure 2-2, the radio set being tested should be located near the Model 4131. When testing an individual radio set, the distance between the antenna of the

Model 4131 and the antenna of the radio set is not critical. The FIELD STRENGTH SENSITIVITY adjustment is used to compensate for variation in signal strengths. When several radio sets are being tested and compared, they should each be tested at the same distance from the test set antenna.

2-4. FM DEVIATION INDICATOR. The deviation indicator is stored in the case lid with its panel and connectors exposed so it can be used without removing it from the case lid. There are three connectors on the deviation indicator: two female BNC connectors for the RF IN and OUT and the earphone connector. Connect the radio and deviation indicator according to the connection diagram in figure 2-3, and the following instructions.

a. Place the OFF/ON switch in the ON position and observe the TUNE lamp. If the lamp fails to light, the battery is low and must be replaced (paragraph 5-6).

b. Use the RF power cable stored in the test set to connect the radio set antenna connector to the RF IN connector on the deviation indicator.

c. Connect either the radio set antenna or the coaxial load resistor cable to the RF OUT connector on the deviation indicator.

d. If the load resistor is used as the RF line termination, position the case lid to ensure air convection around the lid will aid in heat dissipation.

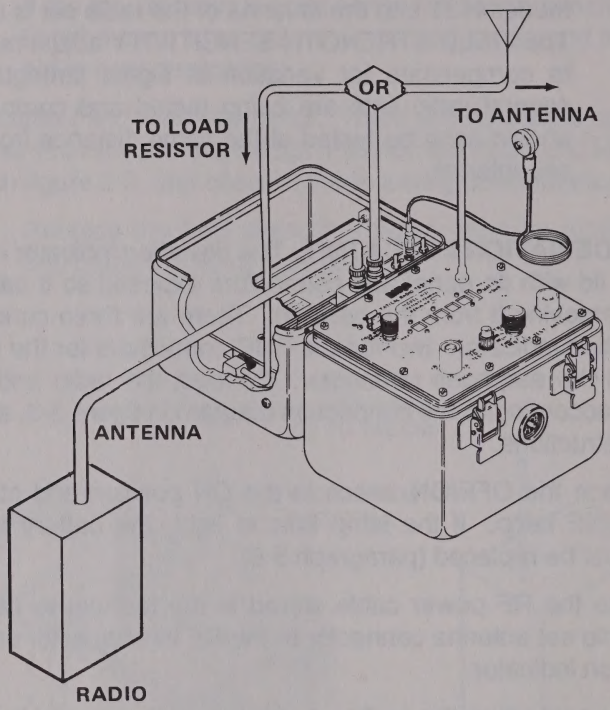


Figure 2-3. Deviation Indicator Connection Diagram

CHAPTER 3
THEORY OF OPERATION

3-1. GENERAL. The Model 4131 Tactical Radio Test Set terminates, samples, measures, and analyzes the RF signals generated and detected by the radio set being tested. The coaxial load resistor provides nonradiating termination of the generated RF signal. The deviation indicator samples signal modulation. The 4131 electronics measure and analyze the detected RF signals. As the measurement data is analyzed by the test set microcomputer, the results are displayed in a form selected by the operator. The operator can use these results to grade the radio set performance against acceptable operating standards and against the performance of other radio sets.

3-2. MODEL 4131 CIRCUIT DESCRIPTION. A basic block diagram of the Model 4131 electronics is shown in figure 3-1. All testing activities are controlled by the microcomputer which receives information from the following sources.

a. Front Panel Switches which direct the tests to be performed.

b. Analog to Digital Converter which supplies the measurement data for all tests except frequency and receiver sensitivity, selectivity, and receive frequency.

c. Digital Divider which is used during frequency measurement.

The microcomputer, after receiving measurement data and instructions, sends the results to the display. The FM spectrum generator produces the calibrated output signals at even 5 MHz frequencies from 30 to 90 MHz for use during receiver sensitivity checks. These signals are input directly to the RF coupler section located between the RADIO and ANTENNA connectors.

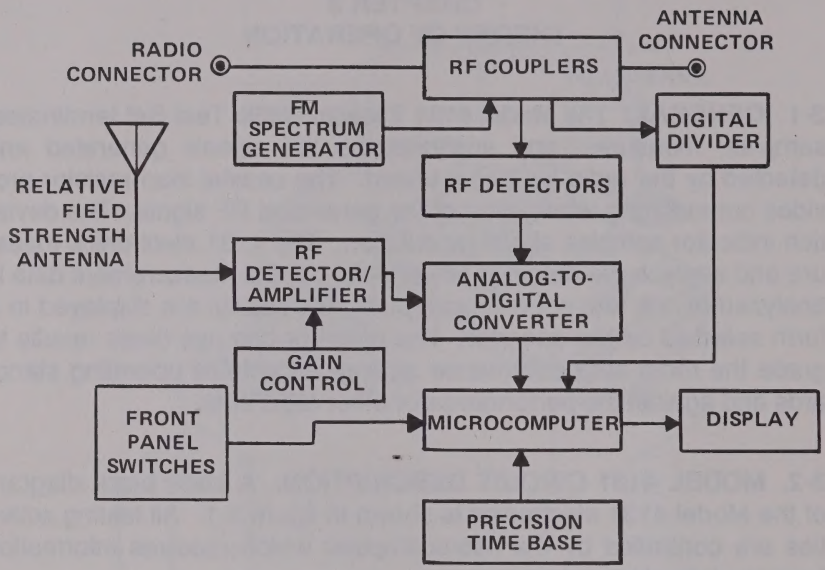


Figure 3-1. Model 4131 Basic Block Diagram

3-3. FM DEVIATION INDICATOR. The FM Deviation Indicator detects the presence and linearity of the frequency modulation in a RF carrier. It uses an FM receiver to remove the modulating intelligence from the RF signal. This recovered audio signal is used to turn on the deviation lamp, or it is output to an earphone assembly for monitoring.

3-4. COAXIAL LOAD RESISTOR. The load resistor is selected for its compact and efficient design. It is quite small for its relatively large power handling capacity. This is achieved through a unique flat plane resistor and the materials of the conduction system and substrates. The load resistor is permanently mounted to the case lid which acts as a heat sink.

CHAPTER 4
OPERATION

4-1. GENERAL. The Model 4131 Tactical Radio Test Set is used to test and grade FM VHF radio sets for maintenance and tactical purposes. It tests the performance of a radio set by measuring and analyzing the RF signals generated and detected by the radio set. The operating functions of the test set measure and analyze RF signal characteristics. Table 4-1 lists characteristics measured by the test functions, and references the setup and operating instructions for each test.

4-2. OPERATING OVERVIEW. Refer to figure 4-1. The Function Switch and the PUSH TO TEST pushbutton control the Model 4131 operating functions. The pushbutton initiates 45 seconds of instrument operation. The 45-second operating period can be reset to continue for 45 seconds at any time during the testing. Each time the pushbutton is pressed, another 45-second operating period begins. The Function Switch selects the functions that operate during the 45-second period. Several functions with the same setup requirements can be selected during an operating period. To stop operation before the period times out, set the selector switch to the SELF TEST position.

4-3. TEST SESSION PROCEDURE. Whether performing a single test on one radio set or a series of tests on a group of radio sets, conduct the test session according to the following instructions.

a. Unpack the Model 4131 equipment in accordance with paragraph 2-2.

b. Refer to paragraph 4-4 and perform the SELF TEST procedure. If the unit does not pass the SELF TEST, perform diagnostic

tests and repair as required; and/or obtain a functional unit and proceed with the test session.

Table 4-1. Model 4131 Test Functions

Tested characteristic	Switch position	Test reference	Setup reference
Forward RF Power	FWD	4-6	2-3.d
Frequency Modulation	LT*	4-11	2-4.
Generated Frequency	FREQ	4-5	2-3.d
Modulation Linearity	AUD*	4-11	2-4.
Receiver Sensitivity	SENS	4-9	2-3.d
Receiver Selectivity	SENS	4-9	2-3.d
Receiver Frequency Calibration	SENS	4-9	2-3.d
Reflected RF Power	RFL	4-7	2-3.d
Transmitted Signal Strength (Relative)	FLD STR	4-10	2-3.e
Voltage Standing Wave Ratio (Calculated)	VSWR	4-8	2-3.d

*LT/AUD Switch on the FM Deviation Indicator

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT
or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY
Equipment failure of the Model 4131 and/or the radio set being tested can occur.

c. After the SELF TEST is performed, the radio set tests can be performed in any sequence. To obtain the most useful results, establish an efficient test plan. Refer to table 4-1 and arrange the test sequence by setup requirements.

d. It is recommended that inline tests be performed before the radiated signal tests. Refer to the appropriate paragraphs and connect the Model 4131 equipment inline with the radio set being tested. If no inline tests are planned, proceed to step f.

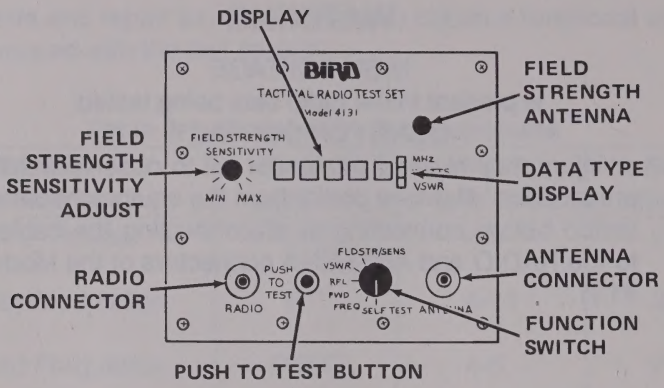


Figure 4-1. Front Panel

e. For each of the inline tests, refer to the procedural paragraph referenced under TEST REFERENCE in table 4-1; and perform the test.

(1) Place the Function Switch in position for the first test function.

(2) Momentarily press the PUSH TO TEST pushbutton, and observe the displayed result. The result of the first selected function displays and will remain displayed until the next function is selected.

(3) Reposition the Function Switch to select the second test function. If it is less than 45 seconds since the pushbutton was pressed in step 2, the result of the second test function displays. If it is more than 45 seconds, the operating period has timed out. Again press the PUSH TO TEST pushbutton momentarily to initiate another operating period. Observe the displayed result of the second selected test function.

(4) Repeat steps (1), (2), and (3) until all the planned tests are completed.

f. Once the inline tests are complete, perform the radiated signal tests. Refer to the paragraphs referenced in table 4-1, and set up the Model 4131 and radio set for the radiated signal tests.

g. Using the Function Switch and pushbutton as described for the inline test, perform the radiated field test procedures referenced in table 4-1.

h. After testing is complete, refer to Chapter 6, and repack the Model 4131 components into the case. Be sure the Function Switch is in the SELF TEST position for storage or shipment.

4-4. SELF TEST FUNCTION. The SELF TEST function verifies that the Model 4131 circuitry and power supply are working properly. The present battery voltage displays at the end of the test. Always run the SELF TEST function *before* performing any measurement or test functions with the Model 4131.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT

or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

a. Place the Function Switch in the SELF TEST position.

b. Depress and hold the PUSH TO TEST pushbutton. For all other functions this pushbutton is momentarily pressed to initiate the operation. For the SELF TEST function only, it is

necessary to hold the pushbutton down during operation of the SELF TEST.

c. Observe the displayed results of the SELF TEST, and refer to table 4-2 to interpret their meaning.

Table 4-2. SELF TEST Indications

Display condition	Indication
Normal (Model 4131 OK)	* First, there is a 2-second delay. * Second, MHz, WATTS, and VSWR indicators, located on the right portion of the display, will blink for 3 seconds. * Third, the number .8.8.8.8.8 and the MHz, WATTS, and VSWR indicators will be on for 3 seconds. * Fourth, the display will indicate the current battery voltage bracketed in dashes. The MHz, WATTS, and VSWR indicators will remain on.
Malfunction (Model 4131 malfunctioning)	If any or all of the numbers or indicators do not illuminate normally, assume a malfunction.
Moving decimal	If the decimal point moves from right to left across the display, the battery voltage is low. This can be a normal condition, even for a new battery. Also, a nearly dead battery will operate the Model 4131 in modes other than SELF TEST for some time. See Chapter 5 for details and replacement instructions.

d. When the SELF TEST routine is complete, the battery voltage displays as a 3-digit number, bracketed in dashes. This number displays as long as the PUSH TO TEST pushbutton is pressed.

NOTE

When the battery voltage is less than 7.5 volts, a decimal point moves from right to left across the display. This indication overrides the test function.

4-5. FREQUENCY (FREQ) TEST. The frequency test function measures the frequency of the RF signal generated by a transmitter. The frequency, in megahertz, appears on the display. Perform the following steps to measure frequency.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT

or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

a. Connect the Model 4131 in the transmission line between the transmitter and antenna or coaxial load resistor, according to instructions of paragraph 2-3.d.

b. Place the Function Switch in the FREQ position.

Table 4-3. Frequency Test Indications

Display condition	Description
30.000 to 90.000 MHz	30.000 to 90.000 MHz will be displayed with ±0.002 MHz accuracy.
Error conditions E-1 thru E-6	If E-1 or E-2 is displayed, STOP TRANSMITTING IMMEDIATELY. See Chapter 5 for a description of error codes.
Moving decimal	If the decimal point moves from right to left across the display, the battery could need replacement. See Chapter 5 for details and replacement instructions.

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY

Equipment failure of the Model 4131 and/or the radio set being tested can occur.

c. Press the PUSH TO TEST pushbutton momentarily. When the transmitter is keyed, the frequency measurement is displayed. (If less than 0.5 watts is being transmitted, the error message

E-5 will be alternately displayed with the frequency measurement data.)

d. Refer to table 4-3 for the meaning of the frequency test function displays.

4-6. FORWARD POWER (FWD) TEST. The forward power test function measures the forward RF power output of the radio set being tested. The power in watts appears on the display. Perform the following steps to measure forward power.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT

or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

a. Connect the Model 4131 in the transmission line between the transmitter and antenna or coaxial load resistor, according to instructions of paragraph 2-3.d.

b. Place the Function Switch in the FWD position.

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY

Equipment failure of the Model 4131 and/or the radio set being tested can occur.

c. Press the PUSH TO TEST pushbutton momentarily. When the transmitter is keyed, the forward power measurement is displayed. (If less than 0.5 watts is being transmitted, the error message E-5 will be alternately displayed with the power measurement data.)

Table 4-4. Forward Power Test Indications

Display condition	Description
0.50 to 100 watts	0.50 to 100 watts will be displayed with an accuracy of ±10%. *
Error conditions E-1 thru E-6	If E-1 or E-2 is displayed, STOP TRANSMITTING IMMEDIATELY. See Chapter 5 for a description of error codes.
Moving decimal	If the decimal point moves from right to left across the display, the battery could need replacement. See Chapter 5 for details and replacement instructions.

* The frequency of the transmission must be within the range of 30 to 90 MHz. See specification, table 1-1.

d. Refer to table 4-4 for the meaning of the forward power test function displays.

4-7. REFLECTED POWER (RFL) TEST. The reflected power test function measures the RF power which is reflected (not radiated) by the antenna as a result of transmission line-to-antenna impedance mismatch. When the antenna is tuned for the maximum radiation of power, the reflected power will be small compared to the forward power.

a. *Reflected Power Considerations.* The following considerations are important to understanding and practical application of the reflected power test results.

(1) *Power Strength.* The greater the forward power is, the greater the reflected power will be, assuming other factors such as the transmission line-to-antenna impedance match remain unchanged.

(2) *Frequency.* The transmission line-to-antenna impedance match varies with frequency. Normally, when using a tuned antenna such as the AS-1729/VRC, the reflected power should be 10% or less of the value of the forward power. If, for example, the forward power is 60 watts, the reflected power should be 6 watts or less.

b. *Reflected Power Test.* Perform the following steps to measure reflected power.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT
or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

(1) Connect the Model 4131 in the transmission line between the transmitter and antenna or coaxial load resistor, according to instructions of paragraph 2-3.d.

(2) Place the Function Switch in the RFL position.

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY
Equipment failure of the Model 4131 and/or the radio set being tested can occur.

(3) Press the PUSH TO TEST pushbutton momentarily. When the transmitter is keyed, the reflected power measurement is displayed.

(4) Refer to table 4-5 for the meaning of the reflected power test function displays.

Table 4-5. Reflected Power Test Indications

Display condition	Description
0.50 to 100 watts	0.50 to 100 watts will be displayed with an accuracy of ±[10%. + (FWD PWR/400)]. *
Error conditions E-1 thru E-6	If E-1 or E-2 is displayed, STOP TRANSMITTING IMMEDIATELY. Note: If forward power is adequate then the E-5 condition indicates a desirable condition: the reflected power is below 0.5 watts. See Chapter 5 for a description of error codes.
Moving decimal	If a decimal point moves from right to left across the display, the battery could need replacement. See Chapter 5 for details and replacement instructions.

* The frequency of the transmission must be within the range of 30 to 90 MHz. See specifications, table 1-1.

4-8. VOLTAGE STANDING WAVE RATIO (VSWR) TEST. The Model 4131 uses the forward and reflected power measurements to calculate the voltage standing wave ratio (VSWR).

a. *VSWR Considerations.* The VSWR calculation performed by the Model 4131 is based on the following formula:

$$VSWR = \frac{\sqrt{FWD} + \sqrt{RFL}}{\sqrt{FWD} - \sqrt{RFL}}$$

(1) The ratio is 1.00, if the antenna is ideally matched to the transmission line.

(2) If the ratio is a number larger than 1.00, the antenna is not matched to the transmission line.

(3) Normally, the VSWR will vary between 1.00 and 2.00 when using a tuned antenna such as the AS-1729/VRC.

b. *VSWR Test.* Perform the following steps to display the calculated VSWR.

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT
or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RADIO and ANTENNA connectors of the Model 4131.

(1) Connect the Model 4131 in the transmission line between the transmitter and antenna or coaxial load resistor, according to instructions of paragraph 2-3.d.

(2) Place the Function Switch in the VSWR position.

CAUTION

If either of the following messages occurs:

- E-1, RF power greater than 120 watts;
- E-2, reflected power greater than or equal to forward power. (The ANTENNA and RADIO connections are probably reversed.)

STOP TRANSMITTING IMMEDIATELY

Equipment failure of the Model 4131 and/or the radio set being tested can occur.

(3) Press the PUSH TO TEST pushbutton momentarily. When the transmitter is keyed, the calculated ratio is displayed.

(4) Refer to table 4-6 for the meaning of the VSWR function displays.

4-9. SENSITIVITY (SENS) TEST. The sensitivity (SENS) test function measures the sensitivity, selectivity, and receive frequency calibration of an FM receiver.

a. *Model 4131 Generated Signals.* For these measurements, the Model 4131 generates a group of 13 calibrated FM signals, each is 0.50 ±0.20 microvolt in amplitude and simultaneously frequency-modulated with both 150 Hz and 1 kHz tones. The frequencies are: 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, and 90 MHz.

(1) *150 Hz Tone.* The 150 Hz tone is used to unsquelch certain receivers, such as the AN/PRC-77, AN/PRC-68, or the AN/VRC-12 series equipped with new squelch. Receivers not equipped with new squelch rely upon old squelch where RF carrier detection is used for unsquelching. The terms old and new squelch are used with receivers equipped with the 150 Hz new squelch. A receiver selector switch is used to select the old squelch or new squelch operation.

Table 4-6. VSWR Test Indications

Display condition	Description
1.00 to 100	1.00 to 100 will be displayed. The accuracy is dependent on the accuracy of the forward and reflected power measurements only. See specifications, table 1-1.
100.PL	100.PL (100 plus) will be displayed when the VSWR is calculated to be greater than 100. This occurs, in particular, when the forward and reflected powers are both equal even if both are zero, such as when the transmitter is not keyed or connected to the Model 4131.
Error conditions E-1 thru E-6	If E-1 or E-2 is displayed, STOP TRANSMITTING IMMEDIATELY. Note: If forward power is adequate then the E-5 condition indicates a desirable condition: the reflected power is below 0.5 watts. See Chapter 5 for a description of error codes.
Moving decimal	If a decimal point moves from right to left across the display, the battery could need replacement. See Chapter 5 for details and replacement instructions.

(2) *1 kHz Tone.* The 1 kHz tone is used for audible detection by the operator during these tests. When the receiver unsquelches, this tone should be heard regardless of the type of squelch (old or new) selected.

b. *Test Sequence.* There are two procedures, one for checking sensitivity (paragraph 4-9.c) and another to check the receive frequency and selectivity (paragraph 4-9.d). They should be performed in the order of presentation for AN/VRC-12 series receivers. Other receivers may be more easily checked following a different order. Keep in mind that the results obtained from these checks are often interdependent. Paragraph 4-9.e explains interpretation of data obtained from these tests.

c. *Sensitivity Test Procedure.* Test receiver sensitivity by the following procedure.

CAUTION

Do not apply RF power to Model 4131 when performing sensitivity test.

(1) Connect the Model 4131 in the transmission line between the transmitter and coaxial load resistor, according to instructions of paragraph 2-3.d. Do not use the antenna in place of the load resistor. If an antenna is used, other radiated signals may be received by the antenna during the test, and the results will not be reliable.

(2) Place the Function Switch in the FLD STR/SENS position.

(3) Press the PUSH TO TEST pushbutton momentarily and perform the following checks. If the operating period times out before all checks are completed, press the pushbutton again.

(a) Squelch off (old squelch off for receivers with new squelch). The 1 kHz tone should be heard at each even 5 MHz frequency from 30.000 to 90.000 MHz across the receive band.

(b) Squelch on (old squelch on for receivers with new squelch). The receiver may or may not unsquelch at each even 5 MHz frequencies across the receive band. Whenever the receiver does unsquelch, the 1 kHz tone should be heard.

(c) New squelch off (for receivers with new squelch only). The 1 kHz tone should be heard at each even 5 MHz frequency from 30.000 to 90.000 MHz across the receive band.

(d) New squelch on (for receivers with new squelch only). The receiver should unsquelch and the 1 kHz tone should be heard at 75 MHz. The receiver may or may not unsquelch at other even 5 MHz frequencies across the receive band. Whenever the receiver does unsquelch, the 1 kHz tone should be heard.

d. *Receive Frequency and Selectivity Test.* Test the frequency accuracy and the selectivity of the receiver by the following procedure.

CAUTION

Do not apply RF power to Model 4131 when performing sensitivity test.

(1) Connect the Model 4131 in the transmission line between the transmitter and coaxial load resistor, according to instructions of paragraph 2-3.d. Do not use the antenna in

place of the load resistor. If an antenna is used, other radiated signals may be received by the antenna during the test, and the results will not be reliable.

(2) Place the Function Switch in the FLD STR/SENS position.

(3) Press the PUSH TO TEST pushbutton momentarily and perform the following checks. If the operating period times out before all checks are completed, press the pushbutton again.

(a) Set the receiver squelch off. Either squelch off, old squelch off, or new squelch off.

(b) Select an even 5 MHz frequency (such as 30.000 or 35.000 MHz) and perform the following checks while listening for the 1 kHz audible tone.

1. Tune the receiver in the smallest increments possible (50 kHz for AN/VRC-12 series) above the even 5 MHz frequency until the audible tone is no longer heard. Note the frequency. The tone should not be heard when 25 kHz above the even 5 MHz frequency.

2. Tune the receiver below the even 5 MHz frequency until the audible tone is no longer heard. Note the frequency. The tone should not be heard when 25 kHz below the 5 MHz frequency.

(c) Repeat step (b), above, for each even 5 MHz frequency possible in the receive band of the radio set being tested.

e. *Using Test Data.* The data obtained from the sensitivity and frequency and selectivity checks described above can be used to pinpoint malfunctions in radio sets. This paragraph lists typical data and resulting conclusions which can be obtained.

(1) *Incorrect Frequency Calibration.* If the 1 kHz tone is heard near one or more of the even 5 MHz settings of the receiver, but these settings are offset from the even 5 MHz frequencies, then receive frequency of the radio set is out of calibration.

Example: the tone is heard at 30.05 and 35.05 MHz rather than 30.00 and 35.00 MHz.

(2) *Poor Receiver Selectivity.* If the 1 kHz tone is heard over a range of more than 50 kHz at one or more of the even MHz frequencies, then the receiver selectivity is bad.

Example: the tone is heard at 30.00 and 30.05 MHz or 34.95 and 35.00 MHz.

(3) *Incorrect Frequency Calibration and Poor Selectivity.* When both conditions (1) and (2), above, occur at the same time, the receive frequency and the selectivity are both deficient.

(4) *Poor Receiver Sensitivity.* If the 1 kHz tone is not heard, receive sensitivity is deficient.

4-10. RELATIVE FIELD STRENGTH (FLD STR) TEST. The relative field strength test function provides a relative measurement of a transmitted RF signal. The field strength antenna of the Model 4131 receives the signal, and the display provides a relative indication of the signal strength from 0 to 100. This indication can be used as a relative measure of field strength to adjust the coupling to hand-held receiver antennas. Perform the following steps to measure relative field strength.

a. Refer to paragraph 2-3.e, and position the Model 4131 and radio set being tested.

b. Place the field strength antenna in the upright position.

c. Place the Function Switch in the FLD STR/SENS position.

d. Press the PUSH TO TEST pushbutton momentarily.

e. When the transmitter is keyed, the Model 4131 will display a number between 0 and 100.

f. Adjust the FIELD STRENGTH SENSITIVITY adjustment so the display reads mid-range (about 50).

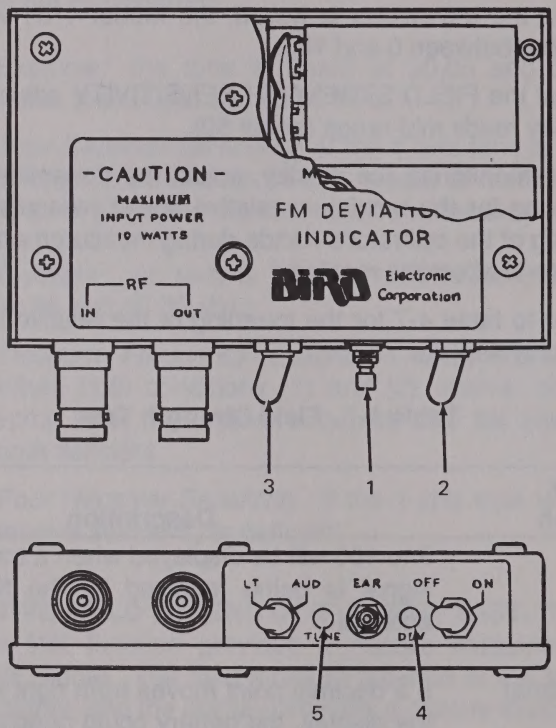
g. While monitoring the display, adjust the transmitter-to-antenna coupling for the maximum relative power measurement. Positioning of the operator's hands during measurement and adjustment will affect the readings.

h. Refer to table 4-7 for the meaning of the relative field strength function displays.

Table 4-7. Field Strength Test

Display condition	Description
0 to 100	0 to 100 will be displayed when a transmitted RF signal is being received by the field strength antenna.
Moving decimal	If a decimal point moves from right to left across the display, the battery could need replacement. See Chapter 5 for details and replacement instructions.

4-11. FREQUENCY MODULATION (FM) DEVIATION TESTS. The FM Deviation Indicator tests for the presence and linearity of the frequency modulation in a RF carrier. Figure 4-2 illustrates the FM Deviation Indicator controls.



1. Earphone connector
2. ON/OFF switch
3. LT/AUD switch
4. DEV lamp
5. TUNE lamp

Figure 4-2. FM Deviation Indicator Controls

WARNING

HIGH VOLTAGE
is present in the radio sets being tested
DEATH ON CONTACT
or injury may result if personnel fail to observe safety precautions. Remove power from the equipment being tested before connecting or disconnecting the cables to the RF IN and RF OUT connectors of the FM Deviation Indicator.

a. Connect the FM Deviation Indicator in the transmission line between the transmitter and antenna or coaxial load resistor, according to instructions of paragraph 2-4.

CAUTION

Damage may result when using modulation indicator with power levels greater than 10.0 watts.

b. Place the OFF/ON switch in the ON position and observe the TUNE lamp. If lamp fails to light, battery must be replaced (paragraph 5-6).

c. To monitor modulation, place the LT/AUD switch in the LT position and observe the DEV lamp. Tune the transceiver to 50.00 MHz. Key transmitter and speak into microphone, if the DEV lamp lights, the transmitter being tested is frequency modulated.

d. To monitor modulation linearity, connect the earphone to the jack, and place the LT/AUD switch in the AUD position.

CHAPTER 5
MAINTENANCE INSTRUCTIONS

5-1. PREVENTIVE MAINTENANCE. The Model 4131 Tactical Radio Test Set requires only simple and routine preventive maintenance.

a. Although the Model 4131 is designed to withstand adverse environmental conditions such as high altitudes, shock, rough handling, and even temporary immersion; it should not be exposed to these conditions unnecessarily.

b. When the test set is not in use, keep the test set components in the case, and the case tightly closed with both clasps.

c. When the test set is not in use, be sure the Function Switch is in the SELF TEST position. Be sure the OFF/ON switch of the FM Deviation Indicator is in the OFF position.

d. Wipe dust and dirt from the surface of the components, front panel, and case on a regular basis.

CAUTION

Do not direct a strong stream of water or compressed air at the case, front panel, or components of the test set.

e. Surface dirt that cannot be wiped off, should be removed with a mild detergent and water. Dry the unit and its components with a soft cloth.

WARNING

Provide adequate ventilation and observe normal precautions when using dry cleaning solvents. Many dry cleaning agents emit toxic fumes that may be harmful if inhaled.

f. Clean the RF connectors with a cotton swab stick dampened with alcohol, freon, or any acceptable dry cleaning solvent.

g. If the test set is not used for a long period of time, remove the batteries from the case bottom (paragraph 5-5) and FM Deviation Indicator (paragraph 5-6).

5-2. ERROR CODES. Diagnostic troubleshooting of the test set is performed automatically by the Model 4131 SELF TEST function (paragraph 4-4). The error messages that display to indicate operating faults are listed and explained in table 5-1. In addition, the calibration and test procedures of paragraph 5-4 can also be used to identify the causes of operating faults.

5-3. PERIODIC INSPECTION. The Model 4131 Tactical Radio Test Set is ruggedly constructed and will normally provide trouble-free service. To ensure that the test set is ready for operation, perform a periodic inspection every six months which includes the following checks and tests.

a. Refer to paragraph 1-4 and check that all test set components are in the case.

b. Inspect the case flange gasket for damage or wear that would destroy the hermetic seal of the case.

c. Inspect the front panel gasket for damage or wear that would destroy the hermetic seal of the case bottom.

d. Check that the hinges operate and separate freely.

Table 5-1. Error Codes

Code	Description
E-1	RF power has exceeded 120 watts. Stop transmitting immediately. [1]
E-2	Reflected power greater than or equal to forward power. (RADIO and ANTENNA cable connections to the Model 4131 are probably reversed.) Stop transmitting immediately. Note: the E-2 code will only be displayed when either or both the forward and reflected power is equal to or greater than 0.5 watts.
E-3 [2]	RF signal if above 90 MHz.
E-4 [2]	RF signal frequency is below 30 MHz. [3]
E-5 [2]	RF power is below 0.5 watts. [4]
E-6 [2]	RF power has exceeded 100 watts

[1] Damage to the Model 4131 will not result unless power levels above 120 watts occur.

[2] With errors E-3 through E-6, the display will alternately display the error code and the data.

[3] When RF power is not being generated or a transmitter is not connected to the Model 4131, the error message E-4 will be displayed alternately with 0 data while performing forward power, reflected power, or VSWR test.

[4] When RF power is not being generated or a transmitter is not connected to the Model 4131, the error message E-5 will be displayed alternately with 0 data while performing a frequency test.

e. Check that the clasps operate and the strikes are not bent. Check that the clasps secure the case lid tightly to the case bottom.

f. Check that the antenna, control knobs. and connectors of the front panel are present and free of damage. Be sure the pushbutton, selector, and sensitivity knobs operate without binding.

g. Check that the protective cover of the display is intact and that the display is visible through it.

h. Perform the Model 4131 SELF TEST (paragraph 4-4).

i. Refer to paragraph 2-2.c and check the battery level of the FM Deviation Indicator.

j. Calibrate and test the performance of the Model 4131 in accordance with the procedures of paragraph 5-4.

5-4. OPERATIONAL TEST. Use the following procedures to calibrate and verify acceptable performance of the Model 4131 Tactical Test Set.

a. The calibration and test procedures must be performed under the environmental conditions specified in table 5-2, and using the following recommended test equipment (or equivalent):

Qty	Description	Recommended equipment
1	Receiver/Transmitter	Memcor RT-246A/VRC
1	24VDC, 1A power supply	Lambda LK351FM
1	30-90 MHz, 30 dB amp	Anzak AMC-140
1	30-90 MHz frequency counter	Hewlett-Packard HP5385A
1	100W, 30-90 MHz, 30 dB attenuator	Bird 8325
1	RF power meter	Hewlett-Packard HP435A
1	Variable RF sampler	Bird 4275
1	0.5-50 watt, 30-90 MHz signal source (less than 1% AM modulation, all Harmonics less than –60 dB below carrier)	
2	100W, 50 ohm loads	Bird 8164
1	Thruline power meter	Bird 43
1	Directional element	Bird 100B
1	Digital voltmeter	Fluke 73
1	Spectrum analyzer	Hewlett-Packard 8559A

Table 5-2. Environmental Conditions of Calibration

Temperature	25°F (10°C)
Humidity	0 to 70% RH
Altitude	0 to 3050 M (10,000 ft)
Attitude	Normal operating

b. *SELF TEST.*

(1) Select the SELF TEST position of the Model 4131 function switch.

(2) Press and hold the PUSH TO TEST pushbutton. After a 2-second delay, the MHz, WATTS, and VSWR indicators will blink for 3 seconds. This is followed by the display .8.8.8.8.8.

(3) Continue holding the pushbutton and turn the function switch to the FREQ position. Release the pushbutton. The test set should turn off after approximately 45 seconds.

(4) With the function switch in the FREQ position, press the pushbutton. Check each mode for the indications listed in table 5-3.

Table 5-3. SELF TEST Indications

Mode	Display	Error code	Units
FREQ	.000	E5	MHz
FWD	.00	E4	WATTS
RFL	.00	E4	WATTS
VSWR	100.PL	E4	VSWR
FLD STR/SENS	0		

c. *Battery Test.*

(1) Set the function switch to the FREQ position and press the pushbutton.

(2) Maintain a powerup condition for at least 5 minutes by periodically pressing the pushbutton.

(3) Press and hold the pushbutton. Set the function switch to SELF TEST. Continue holding the pushbutton until the battery voltage is displayed. The indicated battery voltage should be 7.50 volts or greater.

d. *Receiver Sensitivity Function.*

(1) Set up the equipment as shown in figure 5-1, view (a).

(2) Set the function switch to the FLD STR/SENS position and press the pushbutton.

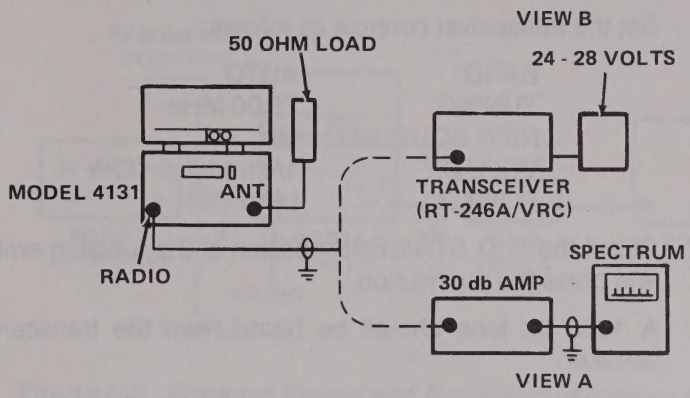


Figure 5-1. Sensitivity Test Setup

(3) The two-tone FM signals that are generated inside the Model 4131 will be applied to the input of the amplifier. The amplifier provides 30 dB of gain so that the signals can be seen on the display of the spectrum analyzer. The analyzer should display signals with peaks that occur every 5 MHz at levels between –81.43 to 87.45 dBm. Any spurious noise should have a peak amplitude of –90 dBm or less. If noise exists with a peak amplitude greater than –90 dBm, turn off the Model 4131 and check if the noise disappears. This would indicate that the noise was caused by the Model 4131 and could be due to internal cabling or a defective comb generator.

(4) Check the amplitude of the signals every 5 MHz from 30 to 90 MHz. Record the amplitude of each signal by first subtracting 30 dB for the gain of the amplifier. The final data should be –110.08 to –117.94 dBm.

(5) Connect the equipment as shown in figure 5-1, view (b).

(6) Set the transceiver controls as follows:

BAND	AUTO
TUNING	75.00 MHz
NEW SQUELCH	ON
VOLUME	1/4 from full CCW
POWER	LOW

(7) Select the FLD STR/SENS position of the function switch and press the pushbutton.

(8) A 1000 hz tone should be heard from the transceiver speaker.

(9) Adjust the transceiver tuning frequency 50 Khz to first one side of 75 MHz, then the other. No tone should be heard at these two frequencies.

e. *Forward Power and Frequency Test.*

(1) Connect the equipment as shown in figure 5-2.

(2) Set the function switch to the FWD position and press the pushbutton.

(3) Starting at 30 MHz, apply 50.0 watts of RF power. Record the Model 4131 indication which should be between 40.0 to 60.0 watts. Turn the function switch to the FREQ position and record the displayed frequency. Also record the frequency of the source as displayed on the external counter. The Model 4131 should match the external counter to within ±2.0 Khz.

(4) Repeat step (3), above, every 5 MHz up to and including 90 MHz.

(5) Turn off the RF power.

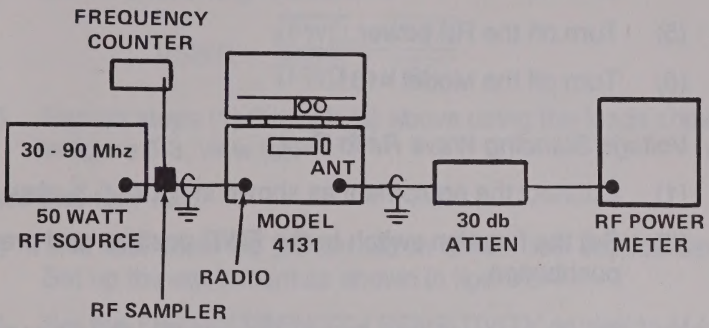


Figure 5-2. Forward Power and Frequency Test Setup

(6) Turn off the Model 4131 by turning the function switch to the SELF TEST position.

f. *Reflected Power Test.*

(1) Reverse the connections show in figure 5-2 so that the RF power is applied to the ANTENNA port and the attenuator is connected to the RADIO port. Set the function switch to the RFL position.

(2) Locate the three inline screws in the upper left hand corner of the Model 4131. Remove the third screw from the left and insert the shorting bolt (p/n 4130-087) until it rests against the upper pc board. Connect the shorting bolt to case ground with a wire jumper. Press the push-button. This step removes all of the error codes and allows reflected power testing.

(3) Starting at 30 MHz, apply 50.0 watts of RF power. Record the Model 4131 indication which should be from 45.0 to 55.0 watts. If any error codes display, repeat step (2), above.

(4) Repeat step (3), above, every 5 MHz up to and including 90 MHz.

(5) Turn off the RF power.

(6) Turn off the Model 4131.

g. *Voltage Standing Wave Ratio Test.*

(1) Connect the equipment as shown in figure 5-3, view (a).

(2) Set the function switch to the FWD position and press the pushbutton.

(3) Slowly increase the RF power until the Model 4131 indicates 50.0 watts.

(4) Turn the function switch to the RFL position and record the reading.

(5) Turn the function switch to the VSWR position and record the displayed VSWR reading.

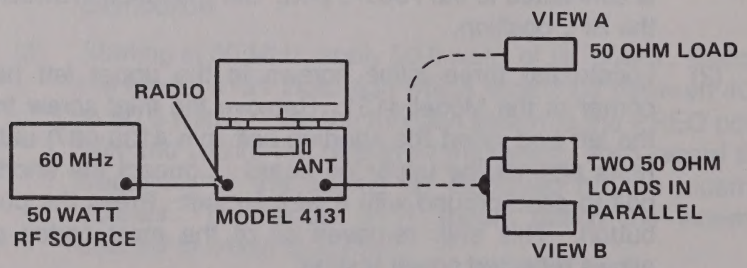


Figure 5-3. Voltage Standing Wave Ratio Test Setup

(6) The VSWR reading should equal the answer obtained from the following calculation.

$$VSWR = \frac{\sqrt{FWD} + \sqrt{RFL}}{\sqrt{FWD} - \sqrt{RFL}}$$

(7) Repeat steps (1) through (6) above using the loads shown in figure 5-3, view (b).

h. *Field Strength Test.*

(1) This test must be performed in a RF free environment. Set up the equipment as shown in figure 5-4.

(2) Set the FIELD STRENGTH SENSITIVITY control to MAX. Select the FLD STR/SENS position of the selector switch and depress pushbutton. The display should indicate 0.

(3) Key the transmitter. The 4131's display should increase to a maximum display of 100. (Note: Orientation of the transmitter's antenna may effect the displayed value.)

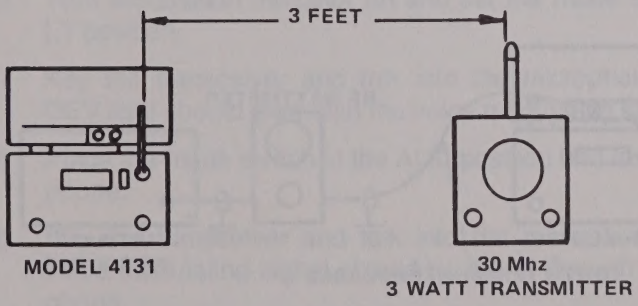


Figure 5-4. Field Strength Test Setup

(4) Unkey the transmitter. The 4131's display should settle to a value of 0.

i. *Power Termination Test.*

(1) Connect the equipment as shown in figure 5-5.

(2) Measure and record the DC resistance of the power termination.

CAUTION

The Model 4131 upper case becomes very hot during this test.

(3) Apply 100 watts of RF power at 60 MHz.

(4) Leave all equipment in this position for at least 15 minutes.

(5) Turn off the RF power and allow the Model 4131 to cool.

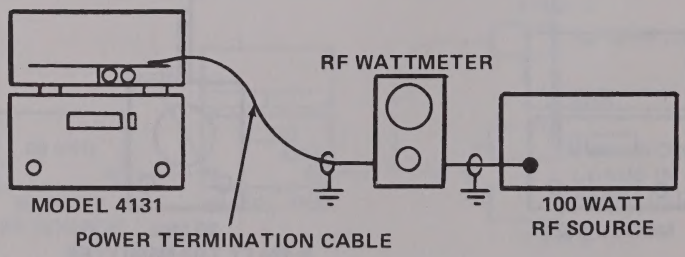


Figure 5-5. Power Termination Test Setup

(6) Measure and record the final DC resistance of the power termination. The DC resistance should not change more than 0.5 ohms.

j. *Modulation Indication Test.*

(1) Connect the equipment as shown in figure 5-6.

CAUTION

Damage may result when using modulation indicator with power level greater than 10.0 watts.

(2) Set the transceiver controls to the following.

BAND	AUTO
TUNING	50.00 MHz
OLD SQUELCH	ON
VOLUME	Fúll CCW
POWER	LOW

(3) Turn Modulation Indicator on and set the mode switch in LT position.

(4) Key the transceiver and talk into the microphone. The DEV light should glow with the voice modulating signal.

(5) Place the mode switch in the AUD position and install earphone.

(6) Key the transceiver and talk into the microphone. The voice modulating signal should be heard through the earphone.

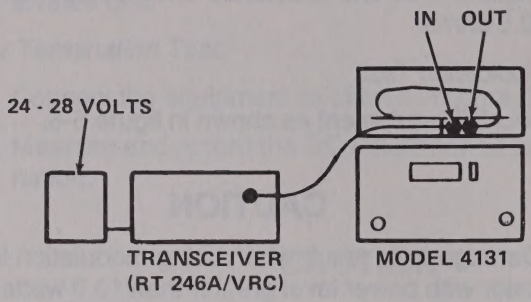


Figure 5-6. Modulation Indicator Test Setup

5-5. BATTERY REPLACEMENT – CASE. The need for battery replacement is indicated when the decimal point moves from right to left across the display. A low battery indication can occur when a test is being performed. If it does, normal testing cannot be continued until the battery is replaced. During the SELF TEST function, the actual battery voltage is displayed. The approximate life of a new battery is 16 to 20 hours.

NOTE

In the SELF TEST function, if the decimal point moves from right to left, a few minutes of operational time in other modes may be available.

WARNING

Personnel can be seriously injured if the lithium battery contained in the Model 4131 is not handled and disposed of properly. Always observe the following guidelines:

- Dispose of the battery properly: never burn, crush, or incinerate.
- Never attempt to recharge the battery.
- Never bypass the fuse.
- If the battery vents gas or becomes hot, stop operating the equipment. Do not handle the battery until it cools and stops venting.

CAUTION

Lithium batteries not used for periods of a few weeks or more or subjected to low temperature for several hours or more, whether contained in the Model 4131 or not, may appear to be dead or discharged. This is a characteristic of lithium batteries. Simply place the function switch in the SELF TEST position and press the PUSH TO TEST pushbutton for 30 seconds. If the battery contains a usable charge, it will operate normally after this time. Failure to observe this caution can result in unnecessary battery replacement.

a. *Battery and Desiccant Replacements.* The part numbers for the battery and desiccant are listed in table 5-4. The desiccant consists of a small pouch containing chemicals used to absorb moisture. It must be replaced whenever the front panel is removed.

Table 5-4. Replacement Parts

Item	Bird Part No.	U.S. Federal Stock No.
Battery	5-1444	6135-01-069-8575
Desiccant	5-1443	6850-00-264-6568

b. *Battery Replacement Procedure.* Refer to figure 5-7 and replace the battery according to the instructions of the following procedures.

(1) Remove 12 screws (1) that secure front panel (2) to instrument case bottom (3).

(2) Carefully lift the front panel, along with associated components, out of the instrument case and set it face down next to the case.

(3) Unplug inline connector (4) on the two wires running between battery (5) and the circuit board.

(4) Remove four screws (6) that secure battery cover (7) to the bottom of the instrument case.

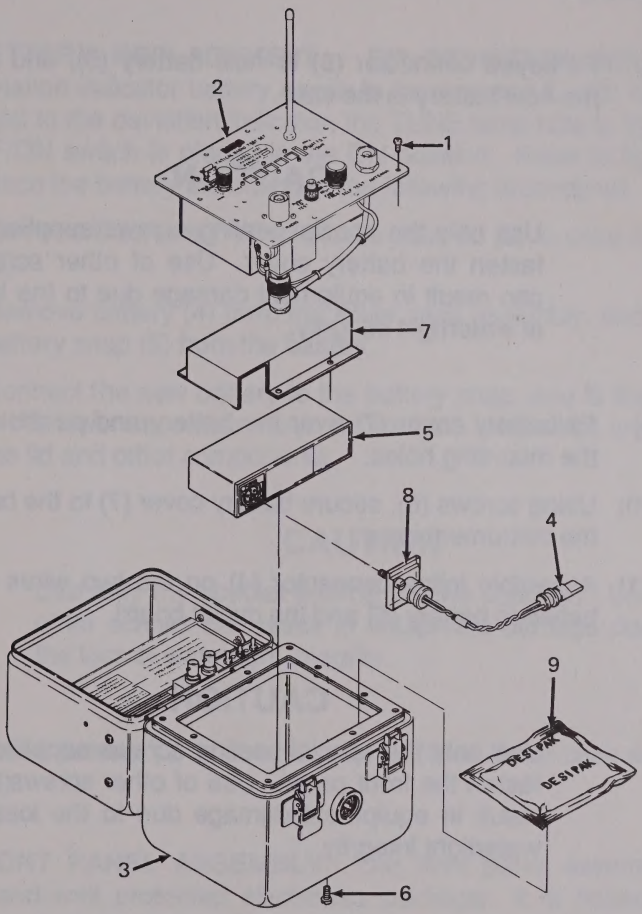
(5) Remove battery (5) from the case.

(6) Unplug keyed connector (8) from the battery.

CAUTION

Install only an approved desiccant. Failure to do so can result in decreased accuracy of the Model 4131 or damage under some environmental conditions.

(7) Remove old desiccant pouch (9) and replace it with a new desiccant pouch.



1. Screw
2. Front panel
3. Case bottom
4. Inline connector
5. Battery
6. Screw
7. Battery cover
8. Connector
9. Desiccant

Figure 5-7. Battery Replacement – Case

(8) Fit keyed connector (8) to new battery (5), and position the new battery in the case.

CAUTION

Use only the special sealing screws supplied to fasten the battery cover. Use of other screws can result in equipment damage due to the loss of watertight integrity.

(9) Fit battery cover (7) over the battery and position it over the mounting holes.

(10) Using screws (6), secure battery cover (7) to the bottom of the instrument case.

(11) Assemble inline connector (4) on the two wires running between battery (5) and the circuit board.

CAUTION

Use only the special sealing screws supplied to fasten the front panel. Use of other screws can result in equipment damage due to the loss of watertight integrity.

(12) Fit front panel (2) to instrument case bottom (3), and secure the front panel tightly to the case bottom with screws (1).

5-6. BATTERY REPLACEMENT – FM DEVIATION INDICATOR. The deviation indicator battery needs to be replaced if, with no cables connected to the deviation indicator, the TUNE lamp fails to light when the OFF/ON switch is placed in the ON position. Refer to figure 5-8, and replace the battery according to the following procedures.

a. Remove 6 screws (1) that secure case lid (2) to case assembly (3).

b. Remove battery (4) from the lower case assembly, and remove battery snap (5) from the battery.

c. Connect the new battery to the battery snap, and fit the battery in the lower case assembly. Be sure the snap wires are clear of the lid and other components.

CAUTION

Use only the special sealing screws supplied. Use of other screws can result in equipment damage due to the loss of watertight integrity.

d. Use 6 screws (1) to secure case lid (2) to lower case assembly (3).

5-7. FRONT PANEL ASSEMBLY. The front panel assembly is a rugged and well protected electronics package. It is housed in an environmentally protective case. When properly used this package should function without breakdown. If components of this package fail, they must be replaced in an electronics laboratory to preserve the accuracy of the instrument. A malfunctioning front panel assembly should be replaced according to the following procedures.

a. Refer to figure 5-9 and remove 12 screws (1) that secure front panel (2) to instrument case bottom (3).

1. Screw
2. Case lid
3. Lower case assembly
4. Battery
5. Snap

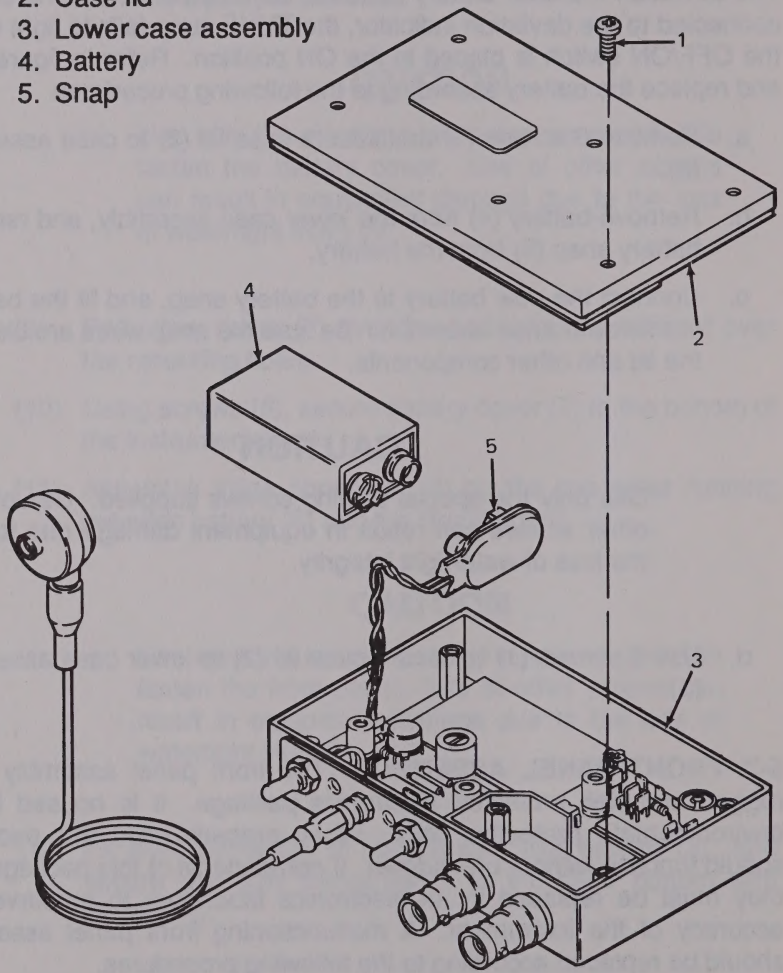
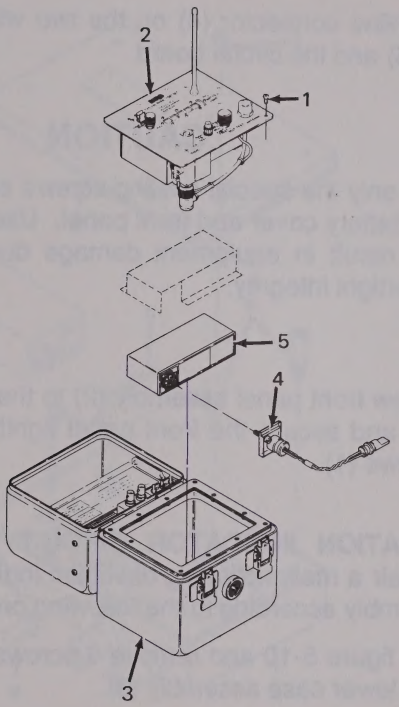


Figure 5-8. Battery Replacement – Deviation Indicator



1. Screw
2. Front panel
3. Case bottom
4. Connector
5. Battery

Figure 5-9. Front Panel Assembly

b. Carefully lift the front panel, along with associated components, out of the instrument case and set it face down next to the case.

c. Unplug inline connector (4) on the two wires running between battery (5) and the circuit board.

CAUTION

Use only the special sealing screws supplied to fasten the battery cover and front panel. Use of other screws can result in equipment damage due to the loss of watertight integrity.

d. Fit the new front panel assembly (2) to the instrument case bottom (3), and secure the front panel tightly to the case bottom with screws (1).

5-8. FM DEVIATION INDICATOR CIRCUIT BOARD REPLACEMENT. To repair a malfunctioning deviation indicator, replace the circuit board assembly according to the following procedures.

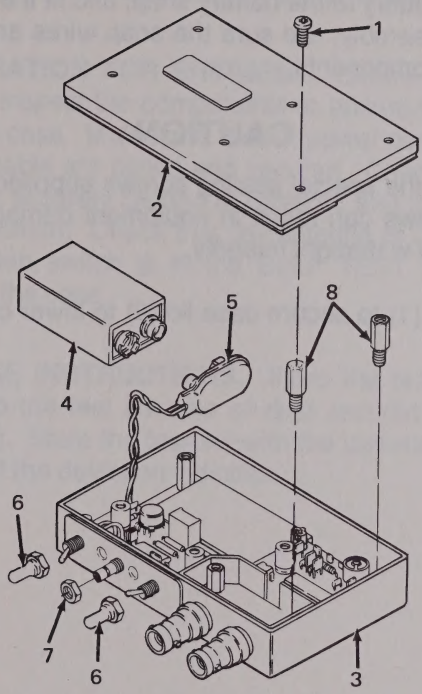
a. Refer to figure 5-10 and remove 6 screws (1) that secure case lid (2) to lower case assembly (3).

b. Remove battery (4) from the lower case assembly, and remove battery snap (5) from the battery.

c. Remove the boot seals and nuts (6) from the toggle switches, and nut (7) from the earphone jack.

d. Remove standoffs (8) that secure the circuit board to the lower case.

e. Remove the circuit board from the lower case and install a new one. Secure it in place with standoffs (8).



1. Screw
2. Case lid
3. Lower case assembly
4. Battery
5. Battery snap
6. Boot seal and nut
7. Nut
8. Standoff

Figure 5-10. Deviation Indicator Circuit Board Replacement

f. Fit boot seals and nuts (6) to the toggle switches, and nut (7) to the earphone jack. Tighten them securely in place.

g. Connect the battery to the battery snap, and fit the battery in the lower case assembly. Be sure the snap wires are clear of the lid and other components.

CAUTION

Use only the special sealing screws supplied. Use of other screws can result in equipment damage due to the loss of watertight integrity.

h. Use 6 screws (1) to secure case lid (2) to lower case assembly (3).

CHAPTER 6
PREPARATION FOR SHIPMENT

6-1. PREPARATION FOR SHIPMENT. Before packing the test set for shipment, inspect the components to ensure they are present and secured in the case. Make sure the RF power connector cable and the load resistor cable are coiled and secured. Check that the FM deviation monitor is securely clipped in position, and the OFF/ON switch is in the OFF position. Check that the antenna is clipped down. Check that the function switch is in the SELF TEST position. Close and securely latch the case.

6-2. STORAGE INSTRUCTIONS. Store the test set in a cool, dry location. Keep the test set free of dust and dirt, and protect it from rough handling. Store the test set with the batteries removed from the lower case and the deviation indicator.